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5 MARCH 1973

SELF-SUFFICIENCY IN ENERGY - A NATIONAL POLICY?

BY

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Self-Sufficiency in Energy - A National Policy?

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USAWC RESEARCH PAPER

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SELF-SUFFICIENCY IN ENERGY - A NATIONAL POLICY.

AN INDIVIDUAL RESEARCH REPORT

by

10

Lieutenant Colonel Vincent Dambrauskas
Signal Corps

US Army War College
Carlisle Barracks, Pennsylvania
11 5 March 1973

12 88p

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ABSTRACT

AUTHOR: Vincent Dambrauskas, LTC, SigC
FORMAT: Individual Research Report
DATE: 5 March 1973 PAGES: 82 CLASSIFICATION: Unclassified
TITLE: Self-Sufficiency in Energy - A National Policy?

The basic question is whether the United States should follow a policy of being self-sufficient in energy resources. The supplies of domestic resources were examined along with projections for energy needs. In addition, future technology and impact of government regulation and environmental concern were assessed for their contribution to energy supply and demand. The projected energy balance sheet was reviewed in light of conditions of National Security to formulate policy recommendations. Data was gathered using literature search. The conclusion was that the United States is not now and cannot be self-sufficient in energy before 2000, however, the long term policy must be self-sufficiency. To achieve this, the United States should take action to: establish a single policy coordinating body for energy, abolish present oil import quota system, implement selected measures to conserve energy, diversify and increase government support of energy research, and in the interim exploit a diversity of foreign sources.

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GLOSSARY

The following terms and numerical relationships are useful in discussions about energy.

BTU - British Termal Unit - The quantity of heat required to raise the temperature of one pound of water, at its maximum density, one degree Fahrenheit. A common unit of measurement for energy in this paper.

Kilowatt - KW - One thousand watts.

Kilowatt hour - Kwhr - One thousand watts - A Unit of energy equal to one thousand watts acting for one hour. Equivalent to 3,412 BTU.

One ton of coal - Equals 25,000,000 BTU (Bituminous coal)

One barrel of oil - Bbl - Equals 42 US gallons.

One Bbl crude oil - Equals 5,800,000 BTU.

One cubic foot of dry Natural Gas - Equals 1,035 BTU

One billion - Equals one thousand million or 1×10^{9}

One trillion - Equals one thousand billion or 1×10^{12}

One quadrillion - Equals one thousand trillion or 1×10^{15}

Fuel Cell - A device capable of converting chemical energy directly into electrical energy.

Solar Cell - A device capable of converting light energy directly into electrical energy.

CHAPTER I

INTRODUCTION

Man's material progress is closely related to his ability to use energy, so much so that today a highly industrialized nation can be likened to a giant with feet made of energy materials. Remove those materials and the giant will collapse. How did man get there?

BACKGROUND

From prehistoric times, man has depended on renewable forms of energy to survive. He survived at the earliest by using muscle power and muscle power was provided by the plants and animals he ate. The animals in turn depended on plants and plants grew because they have the ability to use the energy from the sun to convert minerals of the soil to nutrients. Man continued to develop by making use of animal power and by converting sun's energy stored in wood into heat through fire. The use of heat increased his comfort and made possible the development of more complex tools which harnessed animal, wind, or water power more effectively. Still, man was using renewable forms of energy. It wasn't until after 1830 when we in the US began to use coal. This was a radical change in that we began to tap resources which it had taken nature hundreds of millions of years to produce. The industrial revolution coming after 1870, combined with the discovery of oil on 29 August 1859 at Titusville, Pennsylvania, propelled us into what has been rightfully called the Age of Energy. Today, fossil fuels of coal, oil, and natural gas supply 93% of the world's energy; water power accounts for only 1%; and the labor of men and domestic animals

the remaining 6%.[1] We are almost totally dependent on energy in our daily affairs and the energy is being provided by fossil fuels, which once consumed are gone forever.

For the past two years and especially in 1972, the American public has been hearing about the "Energy Crisis." For a while, the problem appeared to be academic. After all, lights still went on at the flip of a switch, furnaces produced heat when the thermostat was turned on, and the gas station on the corner still sold plenty of hi-test. A cold spell over a part of the country in the last days of 1972 and in the early part of 1973 brought the crisis closer to home. A scarcity of fuel oil and natural gas developed and interfered with people's activities. The cartoons in Figure 1 show the questioning attitude of the public. Measures taken to deal with this situation demonstrated the nature of the crisis. The corrective action consisted primarily of the lifting of oil import restrictions. The plain facts are that US domestic production of energy is not capable of meeting demands and the US is dependent on foreign oil.

STATEMENT OF THE PROBLEM

The basic question then becomes: Should the United States be self-sufficient in energy supplies? Before it can be answered it is necessary to know the situation, to know what is possible and at what price, and to look at the reasons for self-sufficiency. The purpose of this paper is to examine the facts, look at a broad definition of National Security, reach a feasible conclusion with some recommendations for future action.

INVESTIGATIVE PROCEDURES

Much has been written about the "Energy Crisis" and much of it is contradictory. Therefore, care must be taken to look at each source of information with a critical eye. The procedure used in preparation of this paper is to make use of the widest possible number of published sources dealing with projections of supply and demand of energy. The methodology, assumptions, and bias of the sources are examined and discussed. The numerical answers of various sources are also compared to provide a good feel for the range of estimates. The numbers used to draw conclusions are then chosen as the "most probable" and are always within the range of numbers given by the sources. This procedure tends to "average" or balance the optimism and pessimism of a large number of experts and yields a reasonable basis in fact upon which to base opinions and conclusions. The conclusions themselves are individual and subjective, but based on a large sample of forecasts of the energy situation of the US. The news media, primarily newspapers, are used to supplement more authoritative sources with the latest developments in the fuels industry. In addition, the media does provide an immediate forum for public opinion and is useful in gauging the values and reactions of the American people to the "Energy Crisis."

ORGANIZATION OF THE PAPER

In looking at the energy situation of the US, it becomes evident very early that a coordinated and announced US National Policy does not exist regarding any facet of energy. This simplifies the organization

of the paper, since there is no need to state the policy. Instead, the first topic of discussion deals with the supply of energy or what we have. Given that data, we look at research on new energy sources and better ways to use what we have. Next is a look at various projections of energy demand, the methodology used in making these projections, and their validity.

Since government regulation plays a role in energy demand and supply, several major regulatory mechanisms are examined. Combined with this, is the question of pollution control and its impact on the energy industry. To arrive at a conclusion, the energy picture is summarized, National Security defined, and its aspects discussed in the next part ending with a comparison of two energy policies and a look at government research and development effort which tends to reveal the direction of current energy policies. Finally, a conclusion is derived about an energy policy and some recommendations are made for implementing the proposed policy.

It is not the purpose of this paper to make independent projections of the energy situation in the US. The purpose is to collect information from existing projections and competent authorities and reach a balanced judgement on the policy question, taking into account the biases contained in a wide variety of published works.

CHAPTER I

FOOTNOTES

1. US Congress. House. Committee on Interior and Insular Affairs, Fuel and Energy Resources, 1972, p. 677.

CHAPTER II

DOMESTIC SUPPLY OF ENERGY

Where do we stand today? The United States has large resources of energy and produces or extracts them at a prodigious rate, so the question becomes two-fold. How much energy is being used and how much is left?

In considering these questions, new technology and sources not yet in use will be excluded. They will be dealt with in a later chapter. Furthermore, for the purposes of this paper, "domestic" sources or resources means those to be found in the 48 contiguous States and Alaska and their continental shelves (offshore resources). Domestic sources can be considered relatively immune from foreign control. Only an attack on the United States, covert or overt, would threaten physical damage to these sources or interrupt the delivery of energy supplies from them. Alaska could be considered less secure since oil or gas from there may have to be transported by ships. However, interference is not likely during peace.

Of course, even in peace, domestic energy resources are not immune to economic influence from foreign countries. For example, in the 11 years between 1960 and 1971, production of coal in Japan dropped from 52.6 million tons to 31.6 million. During the same period, 606 mines stopped operating.[1] This has been due to the fact that imported coal, much of it from the United States, is cheaper and other forms of fuel have come into wider use. Such international economic competition is a large factor in the energy supply picture.

Today, domestic sources of energy are coal, petroleum, natural gas, nuclear power, and hydroelectric power. Wood is still used as a fuel and accounts for more energy supply than nuclear power but its use is steadily declining and it can be discounted in the future. The word petroleum, as used here, means petroleum products refined and processed from crude oil, including still gas, liquified refinery gas, and natural gas liquids. Crude oil is often found in combination with gas. In the refining process of crude oil, still gas and liquified refinery gas are produced. Conversely, natural gas often contains hydrocarbons which can be obtained through surface condensation or special processing. These liquid hydrocarbons such as natural gasoline, propane, and butane are known collectively as natural gas liquids.

COAL

Of all the energy sources, coal is the most abundant. Reserves of coal are estimated at nearly 3,210 billion tons.[2] Only about 150 billion tons are accessible with current technology but even that amount can last for several hundred years at current rate of consumption.[3] In spite of availability, the nation's electric utilities found themselves short of coal in mid 1970. The shortage was caused by decreasing mine productivity, increasing US exports of coal, mine and railroad strikes, and a shortage of coal cars for deliveries to power plants. Stockpiles at many big power plants dwindled to well below the normal 60-to-90-day supply, in a few instances down to less than a week's supply, and it wasn't until mid 1971 that stocks increased to 70 days' supply.[4] All uses of coal accounted for $12,560 \times 10^{12}$ BTU of energy in 1971, or 18.2% of all energy used by the nation.[5]

PETROLEUM

Petroleum is next in abundance. Proven crude reserves on 31 December 1971 totaled 35,251 million barrels in the lower 48 states and 10,117 million barrels in Alaska.[6] Output during 1971 averaged 11,284,000 barrels per day. This did not satisfy all the demands for petroleum products and also some of the output was exported. Total demand averaged 15,164,000 barrels per day, exports were 223,000 barrels per day, leaving a gap of 4,103,000 barrels per day. The gap was filled by imports and drawdown of stocks.[7] Crude oil imports averaged 1,660,000 barrels per day and petroleum products 2,185,000 barrels per day. Together, imports were 23% of new supply. The nation relied on petroleum for $30,492 \times 10^{12}$ BTU of its energy supply, or 44.2%.[8] The foregoing paints a bleak picture because a simple division of consumption into proven reserves shows that there is only enough domestic oil for only six years at the 1971 rate of consumption. This is not an entirely true picture. The words "proven reserves" are used to denote estimates prepared by the American Petroleum Institute and provide only an inventory of known deposits in the immediate vicinity of existing wells under limiting economic and engineering assumptions. The question that arises is: "What are the total amounts of petroleum that lie under the US?" The US Geological Survey estimates a 500 year supply at current consumption rates; the National Petroleum Council (NPC) suggests an 80 year supply[9] or 385 billion barrels. Unfortunately, these vast reserves may lie at depths or in offshore waters where todays technology may not be able to

recover them. In addition, only 31% of total discovered oil consisting of 425 billion barrels in the US can be recovered with today's technology. If extraction efficiency could be increased to a mere 50% recovery, nearly 60 billion barrels more would become available.[10]

NATURAL GAS

The use of natural gas has grown tremendously since World War II. In 1971 it furnished $22,734 \times 10^{12}$ BTU or 33% of all the energy consumed in the US.[11] Production was 21,923 billion cubic feet in the lower 48 states and 153 billion cubic feet in Alaska. Proved reserves at the end of the year stood at 247,440 and 31,365 billion cubic feet in the lower 48 states and Alaska, respectively.[12] Domestic production was insufficient to meet the total demand and about 4% of it was satisfied by imports from Canada. As with petroleum, there are estimates of some 1,178 to 6,100 trillion cubic feet of natural gas under the continent and its shelves, but once again, some is unrecoverable with current technology.[13]

NUCLEAR POWER

Nuclear power is in its infancy as a producer of energy. As of 31 December 1971, there were 23 nuclear powered electric plants operating, 54 being built, and 51 planned (reactors ordered) for the contiguous United States.[14] The operating plants produced 10 million kilowatts of electricity or about 2.8% of all the electricity in the US. On an energy basis, they accounted for about 0.6% of consumption. Today's nuclear plants use the fission of enriched uranium U-235 isotope as their

"fuel." The isotope is found in ores in very low concentrations and must be concentrated or "enriched" before it can be used in a reactor. To assure continued supply of enriched uranium for operation of nuclear power plants, two things are necessary. One is the availability of ore of high enough U-235 content, and the other is the availability of enrichment facilities or plants. At the present price of $8 per pound of ore, about 25 years of domestic supply is forecast by Mr. McLean, Chairman of the National Petroleum Council's Committee on US Energy Outlook.[15] Should the price increase, mining companies could use far more extensive lower grade ore deposits and "We could run for a hundred years or more with conventional reactors," according to Mr. Schurr of Resources for the Future, Incorporated.[16] That of course assumes that the necessary enrichment facilities will be available. At present, there are only three enrichment plants, all operated by the US Atomic Energy Commission (AEC). Dr. Schlesinger, former Chairman of the AEC, has stated that present plants are sufficient until 1982 and that a decision will be made in 1976 on expansion of capacity.[17] The Atomic Industrial Forum disagrees and has called for a speed up of the uranium enrichment program to prevent the nuclear power plants from running out of fuel in the nineteen-eighties. The basic disagreement is on the timing for new plants and a claim that a six year lead time for new plants envisioned by the AEC is too short.[18] In November of 1972, three private firms indicated an interest in building such a plant. Coupled with this was an announcement of the discovery of new and large uranium ore discoveries in Utah.[19] It appears that domestic supplies of uranium can last until the end of this century for the types of nuclear plants being used today.

HYDROELECTRIC

The last source of energy in wide use today is hydroelectric power or water power. About 15% of all the electricity produced in the US was generated by this water power. It contributed about 4% to the national energy production. It is not likely that this source of energy is going to dry up in the foreseeable future, but because of relatively few remaining hydroelectric sites that can be developed, water power is not likely to increase by more than 45% over today.[20]

The following table shows the current status of domestic supplies:

US ENERGY SUPPLIES IN 1971

Source of Energy	Percent contribution to total energy needs	US self-sufficient	Percent Imported
Coal	18.2	Yes	0
Petroleum	44.2	No	23%
Natural Gas	33.0	No	4%
Nuclear	0.6	Yes	0
Hydro	4.0	Yes	0

TABLE 1

Overall, the nation imported about 11% of its energy needs and could begin to see the bottom of the barrel of its petroleum and natural gas resources.

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CHAPTER II

FOOTNOTES

1. Richard Halloran, "Coal-Mine Disaster in Japan Points Up Dilemma of an Uneconomical Industry," New York Times, 28 November 1972, p. 8.

2. "Historic NPC Study Lays Out US Energy Options," Oil and Gas Journal, 18 December 1972, p. 18.

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9. Edmund Faltermayer, "The Energy 'Joyride' is Over," Fortune, September 1972, p. 100.

10. US Congress, House, Subcommittee on Flood Control and Internal Development of the Committee on Public Works, Relationship of Energy and Fuel Shortages to the Nation's Internal Development, p. 11.

11. Office of Emergency Preparedness, p. A-2.

12. American Petroleum Institute, p. 114.

13. Relationship of Energy and Fuel Shortages to the Nation's Internal Development, p. 435.

14. US Atomic Energy Commission, Nuclear Reactors Built, Being Built, or Planned in the US as of December 31, 1971, p. 2.

15. John G. McLean, "Energy and America," New York Times, 29 November 1972, p. 61.

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17. US Congress, Joint Committee on Atomic Energy, AEC Authorizing Legislation Fiscal Year 1973, Pt. 4, pp. 2307-2317.

18. "A.E.C. is Urged to Speed Enrichment of Uranium," New York Times, 17 October 1972, p. 55.

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20. Winger, p. 50.

CHAPTER III

THE PROMISE OF FUTURE TECHNOLOGY

In the past crises, whether they be a world war, a "missle gap," or a space race, Americans have turned to industry and technology for solutions. In the present energy crisis, industry is the threatened party, as well as a contributor to the crisis. Before looking at the future energy posture or balance of the US, it is important then to examine what promise technology may hold in this situation.

EFFICIENT USE OF ENERGY

The simplest starting point is a look at the efficiency with which energy is used today. The average steam-electric plant is very inefficient user of fuel. The national average heat rate in 1970 was 10,583 BTU per Kwhr.[1] This, compared to direct energy value of 3,412 BTU per Kwhr, means an efficiency of 32%. The remaining 68% of input energy was turned into heat to be dumped into rivers, lakes, oceans, or into the air through cooling towers. Heat rates are a function of steam temperatures and pressures. Any improvements depend on development of economical materials which can operate at higher temperatures and pressures. Even small improvements could result in large fuel savings. However, it is believed that limits of technology are being approached.[2] The national average heat rate has not varied more than 452 BTU per Kwhr in ten years. Some improvement will occur as older plants are replaced or modernized and efforts in this area will continue since fuel costs are a major portion of total cost to utility companies and the incentive to greater efficiency is there. The development

of lighter weight superconducting generators could also increase efficiency,[3] but major savings of fossil fuels cannot be predicted now.

A second area of fuel use with low efficiency is in the transportation area. A car uses about 10% of the energy of fuel in city traffic, the rest goes into heat. In 1970, automobiles consumed about 14% of all the energy used in the US. All of it was derived from petroleum, the fossil fuel in shortest supply domestically.[4] Any increase in efficiency, perhaps through the use of a turbine, use of smaller cars, better mass transit system, could also bring about significant reductions in demand in ~~a~~ critical area. Unfortunately, the American love affair with the automobile is probably too deep rooted to change very quickly. Not until the cost of gasoline has gone up four to five times and an attractive alternative in mass transit is developed, will the American public .tart to restrict its use of the car. This is not likely to happen until the 1990's.

A third area of inefficiency is in the building business. A staff study on energy conservation[5] estimates that thermal losses of a 1500 square foot house in Washington, D.C., can be cut by two-thirds by use of proper insulation. Adoption of its recommendations could result in fuel savings equivalent to 2.4 million barrels of crude oil per day in 1980. However, this would be at a cost of $890 to the homeowners. Once again, unless prescribed by law, the economic incentive is not there until the price of fuel rises considerably. Certainly the potential for savings is there and so is the technology.

FAST BREEDER REACTOR

It is becoming apparent that trying to save or conserve the presently available forms of energy is going to be costly and even then, fossil fuels are finite and will be depleted at some point in time. What seems to be needed is a new kind of cheap and long lasting energy. Nuclear power leaps to mind as a ready answer. As discussed in Chapter II, the present kind of nuclear power is also not inexhaustible and can be expected to become more expensive. But a different technology of nuclear power is becoming available. It is the liquid-metal fast-breeder reactor. In it, the core containing the fissionable isotope U-235 is surrounded with U-238. Neutrons released during the fission of U-235 convert some of the U-238 to plutonium 239, which will fission. The mixture of U-238 and plutonium 239 can be reprocessed and used as fuel. This type of reactor enables the raw material to be used more thoroughly than it is now being used in water cooled reactors and will stretch the supplies of uranium by perhaps a factor of 40. In addition, the breeder reactor operating at higher temperatures by using liquid-metal coolant is more efficient and will produce less heat loss and radioactive waste. President Nixon, in his energy message to Congress in 1971, called the breeder "our best hope today for meeting the Nation's growing demand for economical clean energy." The world's first commercial breeder reactor was started up on 1 December 1972 in Shevchenko, USSR.[6] The US has two experimental breeder reactors operating now[7] but the first demonstration unit is not scheduled until 19[illegible] with the initial commercial

unit operating in 1985.[8] So although nuclear reactors can assume a greater and greater role in electric power generation, it will be some time before this can come about. AEC estimates that 40% of nuclear capacity in the year 2000 will be supplied by breeder reactors.[9] Mr. Simpson, President of the Westinghouse Power System Company, predicts that the use of fossil fuels for power generation will decrease drastically and that by 1990, only one percent of steam power generation will come from the burning of natural gas.[10] Others disagree that change can be that rapid, especially in view of construction lead times and the need for large investments. Nevertheless, the breeder reactor offers an alternative to the use of fossil fuels for generation of electricity.

This brings up a key point, substitutability of energy forms. Electricity, which is a secondary form of energy derived at the present time mainly from the burning of fossil fuels, can obviously be substituted for such things as the gas stove or the gas furnace in the home. At present, it cannot be used to power automobiles or airplanes. It can never be used as a raw material for the making of plastic toys, stretch pants, or tires. To some extent, it can be used in industrial processes where heat is required, such as steel making. Although it appears to be far off, a time will come when what are now fossil fuels will become critical raw materials. Therefore, the generation of electricity from sources other than fossil fuels and the substitution of so generated electricity for other forms fuel is the desirable direction in the energy maze being explored today.

Along these lines, the use of nuclear fusion, solar energy, and geothermal sources appears very attractive. All of them are abundant, decrease reliance on fossil fuels, and are being explored.

FUSION

The fusion of atoms of hydrogen under controlled conditions can release a thousand times more energy than the fission of uranium. Moreover, such a reaction would reduce the problem of radioactive waste and pollution. The materials, heavy forms of hydrogen, deuterium and tritium, are in plentiful supply. Deuterium comes from water. A gallon contains 1/230th of an ounce and costs four cents to extract. Tritium is "bred" in the reactor by neutrons produced in the fusion process. The problem is that sustained fusion reaction has not yet been produced because of the need to obtain temperatures in excess of 100,000,000 degrees Fahrenheit and to contain the reaction so that it does not melt its vessel. Experts contend that it is just a matter of time before these problems are solved and the world will have no further worries about energy, but none of them see it as a reality before the end of the century.[11, 12]

SOLAR

The sun pours onto the earth 100,000 times as much energy as all the electric plants combined. How can this energy be captured and put to use? Part of it is being used by plants which feed us and provide our shelter. The question really is, can it be converted to electricity or fuel? Quite a few possible techniques have been proposed and studied.

A large satellite collecting sun energy through solar cells and beaming the power to earth via a microwave beam is a possibility. The construction cost based on present technology is estimated at over a million dollars per kilowatt and the system seems to be not feasible until much farther in the future.[13] An earthbound power station using solar cells would still cost from $15,000 to $2,500 per kilowatt. Considerable increase in efficiency, lower production costs, and improved lifetime performance of the solar cells is needed to make this concept competitive with nuclear energy.[14]

Another way to tap the sun's energy is to concentrate the sun's rays on a heat receiver (a heat-pipe) by means of a reflector. The heat can then be used to turn a more or less conventional steam turbine generator. Part of the heat can be stored in tanks of molten salt. The heat can then be used at night or as needed at other times. Several variations of this technique have been studied, but all show costs much higher than present nuclear plans and all require additional technological study prior to implementation. Spokesmen for the AEC think that such systems are also a long way off.[15]

On the other hand, K.W. Boer, Director of the Institute of Energy Conversion at the University of Delaware, believes that a home unit of solar cells installed on a roof of a house can be used to relieve the load on central power stations at a moderate cost and conserve fuels.[16] The Committee for Nuclear Responsibility, Inc., which includes at least four Nobel Laureates, states that ". . . there is no question at all concerning the technical feasibility of converting solar energy to a

variety of useful energy forms . . . Rather it is a question of what will be the ultimate cost per BTU of energy or per Kwhr of electricity."[17] K.W. Boer states that with $5 million funding for research and development a pilot home roof facility can be built to demonstrate operation in three years and that large scale terrestrial plants can make a marked impact on the national energy budget in the early 80's.[18] Such enthusiasm appears unwarranted and it is doubtful that solar energy will have any appreciable impact before the 1990's.

GEOTHERMAL

If solar energy seems to elude man's grasp at present, the heat from the depths of the earth, geothermal power, has been in use in Italy since 1904. Natural steam,produced by the heated core of the earth, has been used to turn turbines and generate electricity not only in Italy, but in New Zealand, Iceland, and the US. In the US, there is only one such plant, near San Francisco, which is expected to produce a half a million kilowatts by 1975.[19] Natural outpourings of steam are few, however, geothermal energy could be harnessed by drilling deep shafts into the earth and then circulating water through them. The water, converted to steam by the earth's heat, can drive turbines turning electric generators. Geothermal energy is a huge resource. It is estimated that heat stored in water under Imperial Valley of California, if used at the rate of 1% per year for power production and returned to the ground for reheating, could produce 487 to 1462 billion kilowatt-hours per year or roughly 31% to 95% of America's 1970 production of electricity.[20]

Former Interior Secretary Walter J. Hickel, a proponent of geothermal power, was recently the principal investigator for the University of Alaska study which was sponsored by the Research Applied to National Needs program of the National Science Foundation. He proposes a ten year research and development program costing $684.7 million on geothermal energy. He forecasts that 132,000 megawatts of electric power could be operating in the nation by 1985 if his proposal is funded.[21] Dr. V.E. McKelvey, director of Geological Survey is not that optimistic and indicated that growth estimates depended on the gathering of further factual data and assumptions on future technology.[22] Again, it is doubtful that geothermal power will make a large impact on the energy picture before 1990's.

There are projects which hold promise in decreasing US dependence on imports of fossil fuels. These projects deal with improving the use of coal and in extraction of oil from shale.

SYNTHETIC GAS

On 15 November 1972, the El Paso Natural Gas Company filed an application with the Federal Power Commission for approval to construct the world's first commercial complex to convert coal into synthetic gas. It is designed to produce 250 million cubic feet of gas per day, will cost $420 million, and initial production is scheduled for 1976.[23] This kind of a plant needs large scale mining operations to support it, needs large quantities of water, wastes about one third of the energy content of the coal in the conversion process, and produces gas at a cost

of about $1 per million BTU. The average wellhead price of natural gas in 1971 was about 18.2 cents per million BTU. At the "city gate" price, synthetic gas would be about three times more expensive than natural gas is at present. Nevertheless, synthetic gas from coal is expected to account for 3.5 billion cubic feet per day of the total gas demand in 1985.[24]

MAGNETOHYDRODYNAMICS

Electricity can be made by hot, ionized gas flowing past a magnet. This process, magnetohydrodynamics (MHD), could use coal as a fuel and could be up to 60% efficient because after part of the energy is converted directly into electricity, the hot gases can be used to fire a regular boiler-and-turbine generator. A large MHD generator designed to deliver 25,000 kilowatts started initial operation in 1971 delivering electricity to Moscow.[25] In the US, laboratory work is being carried out, but not on a large scale. Use of MHD could have a significant impact on conservation of natural gas and oil by using more coal and doing it more efficiently. However, it took the USSR about seven years to build a pilot plant. Even a full US commitment to MHD technology today would not have an impact by 1985 on the total energy situation.

SHALE OIL

In the Western US, there are large deposits of shale saturated with oil. These are estimated to contain 1.8 trillion barrels of oil. Of

this, 129 billion barrels are in zones that exceed 30 feet in thickness and contain 30 gallons of oil per ton of shale, or in other words, are feasible to extract.[26] At present, there are no economically feasible ways to exploit this large resource. The technology is not too complicated since oil could be retorted, or boiled off, from the rocks. The process requires movement of large amounts of earth and needs water for cooling. Only at prices of crude oil substantially higher than they are today, would it be economical. When this will happen is hard to estimate, but leadtimes for research, development, and construction would indicate that even if price of crude oil were high enough today, shale oil production would not be significant in 1985.

HYDROGEN

A very interesting and different proposal for a new source of energy has been made recently and is receiving attention in the periodicals and that is a hydrogen economy. The essentials of the proposal are to build a number of fast breeder nuclear reactors on platforms offshore. Use them to generate electricity and use the electricity right there to generate oxygen and hydrogen by electrolysis of water. The hydrogen can then be carried to land by pipeline and connected into existing and future pipelines. Because hydrogen is much lighter on a volume basis than natural gas, modifications to existing pipelines and existing home or industrial installations would have to be made. It is estimated that hydrogen transmission would cost twice that of natural gas, but still be one half to one third the cost of transmitting electricity the same distance over extra-high voltage transmission lines.[27] Hydrogen can also

be compressed and cooled to liquid form at -423° Fahrenheit, has about two and a half times the energy by unit weight of gasoline, and with some mechanical modification, all types of internal-combustion engines can burn it. When hydrogen is burned, the by-products are water and some small amounts of nitrogen oxide. In the summer of 1972, two cars using hydrogen won the top honors in the emission tests of the Urban Vehicle Design Competition.[28] In addition, hydrogen can be used for direct reduction of iron ore, dispensing with coke and coal and can be converted into other more manageable fuels such as ammonia, hydrazine, or methanol. Furthermore, hydrogen can be fed into a fuel-cell and converted to electricity at energy-conversion efficiencies of 60 to 80 percent, making possible efficient electric automobiles and self-contained homes which would not need any electric distribution systems from central power plants. Today, hydrogen is derived from oil or natural gas and then liquefied. With this complex process and relatively small production runs, (12 billion pounds a year) it is about 50 percent more expensive than gasoline on an energy-per-unit-weight basis. Large scale production could make the costs competitive.[29] Some work on the use of hydrogen has been going on for a decade, principally by the Institute of Gas Technology in Chicago. This group believes that hydrogen will enter the economy first as a mixture to stretch natural gas supplies and that this may happen within a decade.[30]

In short, although technology promises a number of techniques by which additional sources of energy can be tapped, the only two feasible

before 1985 appear to be the breeder reactor and synthetic gas. As will be seen in the next chapter, these two advances are the only ones coaidered significant by all the projections of energy demand and supply to the year 1985, or for that matter, the year 2000.

CHAPTER III

FOOTNOTES

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CHAPTER IV

PROJECTION OF ENERGY BALANCE SHEET

DEMAND PROJECTION METHODOLOGY

The general and accepted way individuals or organizations forecast energy needs and supplies is the building-block method. A typical study, such as the one made by the Chase Manhattan Bank in June 1972, subdivides the energy market into blocks. The blocks most commonly used are industrial, electric utilities, transportation, residential, and commercial. Historical data is examined to determine the energy used by each block and from that, to determine the rate of growth of energy use by each block. For example, between 1955 and 1970, energy use in the transportation market grew at an average rate of 3.4% per year. The next step is to determine the rate of growth of this market for the future, let's say the years 1970 to 1985. Many factors are considered. Population statistics show increase in household formation. This means more cars. The trend of greater growth of suburbs indicates more multicar households. Better roads, disporsal of economic activity, growing air travel, growing leisure travel, are all studied to determine the expected growth rate of the transportation market. Based on this, an average expected growth of energy use in this block is 3.6% per year for the period of 1970 to 1985.

The next step is to project energy use for the market block by types of fuel. Once again, historical data is examined to find how much of each type of fuel was used by the block. Then, based on economic

projections of growth for segments of the block, fuel needs are projected. In the transportation market, automobiles accounted for 53% of total fuel use. The total number of automobiles is expected to increase by 50% between 1970 and 1985. Technology is then assessed to see if new devices, such as electric cars, can be expected to change existing patterns of fuel use. Taking all these factors into consideration, projections are then made of how much of each type of fuel will be needed for each market block. The market blocks are added up to arrive at the total requirements for each kind of fuel or energy. The process is summarized in Figure 2.

BLOCK METHOD OF FORECASTING ENERGY DEMAND

Factors Used to Estimate Demand

Historical Data
Estimated Growth
Demographic Studies
Estimated Economic Growth
Technology
Environment
Regulation

	Energy Type Used					
Market Blocks	Coal	Oil	Gas	Hydro	Nuclear	Tot.
Industrial	x	x	x	x	x	x
Electric Utilities	x	x	x	x	x	x
Transportation	x	x	x	x	x	x
Residential	x	x	x	x	x	x
Commercial	x	x	x	x	x	x
Total	x	x	x	x	x	x

Figure 2

DEMAND STUDIES CONDUCTED PRIOR TO 1972

Over the past decade, a number of studies have addressed the question of US energy needs. Thirty such studies have been collected and summarized by Congress.[1] They can be divided into two groups: 19 reports

completed between 1960 and 1969 and those completed since 1969. All the studies suffer from the lack of precise definitions of such terms as "demand," "requirements," or "consumption." In spite of these and other problems to be discussed later, the diversity and breath of these studies can serve as a very useful tool in the estimate of US energy needs.

Examining the first group, and excluding those that do not deal in total energy needs, the range of values for 1980 is from $79{,}200 \times 10^{12}$ BTU to $97{,}825 \times 10^{12}$ BTU with a mean value of $88{,}200 \times 10^{12}$ BTU. The second group projects values for 1980 of from $95{,}145 \times 10^{12}$ BTU to $105{,}000 \times 10^{12}$ BTU with a mean value of $100{,}700 \times 10^{12}$ BTU.

There is very little overlap between the two groups and the more recent studies show higher demands for energy. It must also be noted that four studies in the first group that gave projections for 1970 were proven to be below the 1970 actual consumption by 5 to 11 percent. This confirms that the making of projections is not a well defined technique and that near term estimates should be more precise than long term ones. Some specific assumptions in these studies were:

o Population growth of 1.6 percent per year was used.

o The price of fuels was assumed to retain the existing relative shares of the market. That is, there would be no large increase in the overall price of fuel compared to other goods and services and there would not be a drastic change in the price of one fuel compared to another.

o Availability of fuels was assumed. That is, although there may be some limitation in availability of domestic fuel, it was assumed that world wide it would be available.

o Technology was assumed to be evolutionary with no revolutionary changes in most studies, but a sizeable increase in nuclear generating capacity was envisioned.

o Stability of the economy and the international relations was probably an inherent assumption of all the studies.

It appears that assumptions about the gross national product, population, and business and international stability are first of all necessary to conduct any sort of a study and second, can be accepted as being reasonable.

The assumptions about prices bear some discussion. It is difficult to estimate the relationship between the cost of energy and the demand. Standard Oil Company (New Jersey) estimates that a 10% price decrease on oil, would increase demand by 1%.[2] However, that is not the question. The reverse is of greater importance, that is, how would demand decrease with increasing prices? One estimate of oil price-elasticity is 0.25 in the short run.[3] This means that a 1% change in relative price should cause a 0.25% change in quantity demanded. However, this applies only to well-head prices of crude oil. Crude oil is the source of gasoline, jet fuel, oils, asphalt, etc. There are no substitutes for these products. In a refinery, all these are made in variable fractions from crude oil. Therefore, a rise in the price of crude can be offset by the refiner by

making the proportion of higher priced products greater. To the consumer, large investment costs are involved in the use of energy. For a homeowner, the change from oil to gas heat constitutes a large investment. The price of oil would have to rise substantially above gas for him to consider a change to gas. He would also have to have a reasonable expectation of stability of gas prices over a long period of time. The same kinds of considerations govern the choice of fuels in industry and thermal electric generating plants, only the investment costs are more substantial and conversion times longer. All these factors tend to make the short term demand for energy price-inelastic.

On the other hand, if the price of all fuels were to increase proportionally, some decrease in demand should occur. There is little question that prices will rise. The steady depletion of fossil fuels, the higher exploration costs in hostile environments such as the North Slope of Alaska, the demands by oil exporting countries for higher prices and shares of ownership and profits, and the large investments required to continue to supply the rising demand for energy all point to inevitable rise in the cost of energy. The National Petroleum Council estimates oil prices will have to rise by 125% and gas by 250% so that adequate exploration and production is encouraged.[4] The impact of these increases on demand is difficult to assess.

It is interesting to note that much more effort has been put into the study of the relationship of price to supply of oil and gas or what price is necessary to stimulate additional exploration and production.

An implicit assumption in these studies has been that demand is not sensitive to price. Perhaps this has been due to lack of experience since fuel prices had exhibited remarkable long term stability. For example, the cost of fuel to power stations is shown in Table 2.

Costs of Fuels at US Thermal Electric Power Stations[5]

Year	Cost of all Fuels in cents per million BTU
1948	26.7
1955	24.3
1960	26.2
1965	25.2

Table 2

Additionally, only 7 cents of the consumer dollar goes to direct energy purchases (compared to 5 cents per dollar for alcohol and tobacco.)[6] The nation's total energy bill is about 4% of G.N.P. exclusive of taxes.[7] From all of the above, it appears that there is much room for energy price increases before demand is seriously affected. The net result is that the assumption of relative price stability of fuels in the studies of energy needs was reasonable at least for the near future.

The assumptions about availability of fuels and evolutionary growth of technology stem from the methodology used in the studies. With the exception of one study, all the others were based on extrapolation of trends, tempered by judgement. Projections could not be made at all if a drastic change were introduced in either availability of a type of fuel or in technology. The interaction of such changes in a

complex and large economy of the United States is not well understood and econometric models do not exist to make accurate forecasts based on abrupt, extraordinary events.

In sum, energy need projections must be looked at as the ideal forecasts based on extrapolation of past trends. As such, they are probably on the low side, as those studies conducted between 1963 and 1968 proved to be for 1970. Figure 3 shows in graphic form a summary of projections including the low, high, and mean values of the forecast US energy needs. The very low values for the low projections for 1980 and 2000 are from the Resources for the Future, Incorporated study conducted in 1963. This same study was proven 11% low in its projection for 1970.

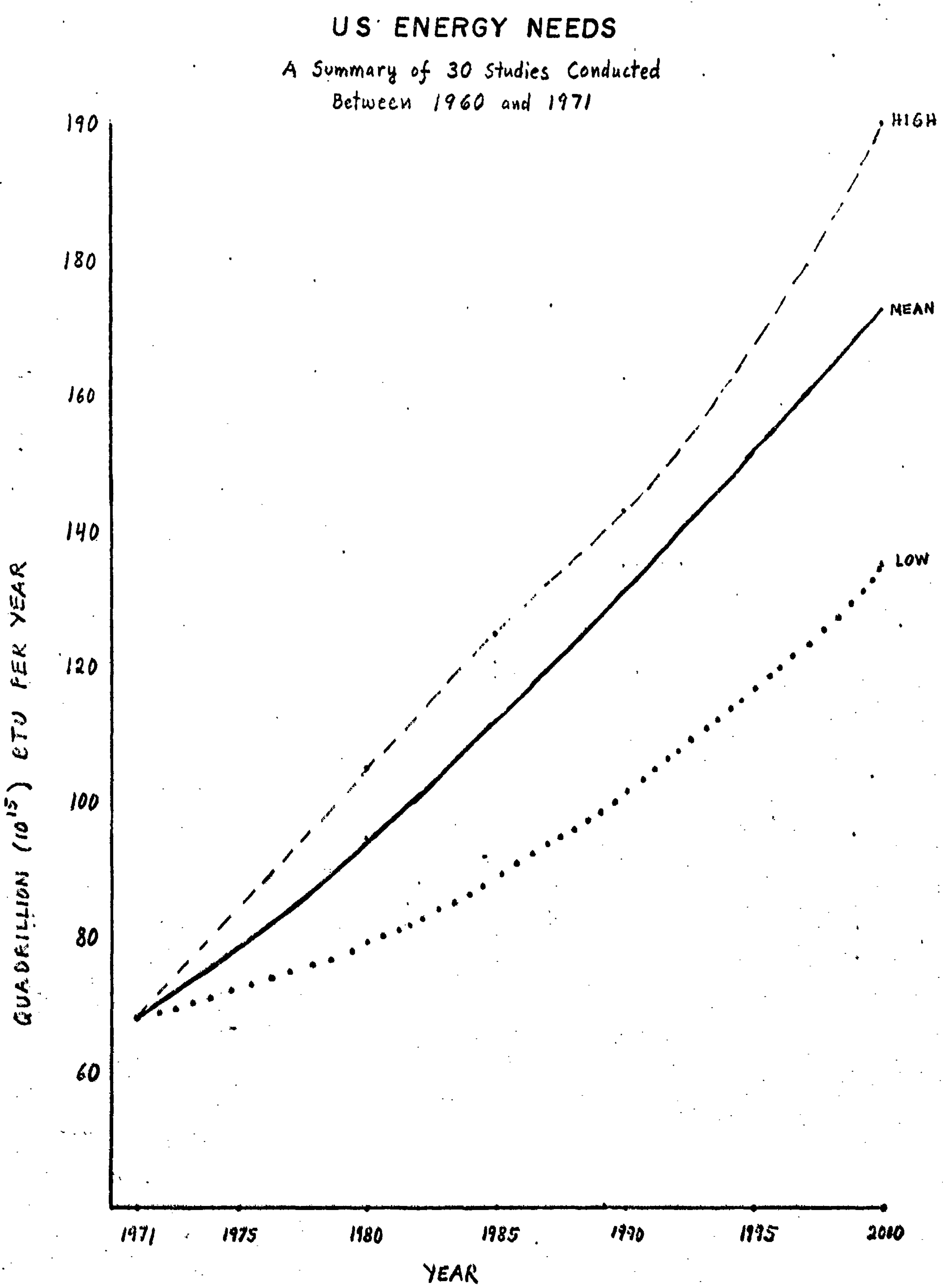
US ENERGY NEEDS
A Summary of 30 Studies Conducted
Between 1960 and 1971
HIGH
MEAN
LOW
QUADRILLION (10^{15}) BTU PER YEAR
190
180
160
140
120
100
80
60
1971
1975
1980
1985
1990
1995
2000
YEAR

FIGURE 3

SUPPLY PROJECTION METHODOLOGY

The next step is to determine the supply of energy. This is perhaps the most ambiguous and uncertain portion of any study. Once again, historical data is collected to see what the growth has been in each energy source area. In times of plentiful supply, it was easy to assume that the market place will operate under the laws of supply and demand and the required fuels will become available. Forecasts in those days merely served as indicators of where the capital investments were likely to gravitate.

Today, when the schools in Denver have to close during the cold spells, when each summer brings blackouts and brown-outs, and the US must import 23% of its petroleum, forecasting energy supply situation is a much more difficult task. It is compounded by a maze of often contradictory government regulations, difficult to accurately predict changes in technology, imperfect understanding of price elasticity of supply, substitutability of one form of fuel for another, need for large sums of capital, the impact of emphasis on the environment, and the imperfect ability to estimate available reserves. Therefore, after examination of historical data and establishment of a trend, most studies survey potential new sources of supply of fuels and then make reasonable estimates on the interaction of the above mentioned factors to arrive at a final figure for supply of fuels to be expected from domestic sources in a future year or years.

Quantitative analyses tend to be general, such as: "Based upon the amount of oil that logically could be expected to be found as a result of an 85 billion dollar investment, the nation's productive capability in 1985 is . . . 15.0 million barrels per day."[8] A statement of this kind implies a number of assumptions and raises a number of questions.

Some implied assumptions:

- o A growing economy without major business cycles.
- o Relatively peaceful international situation.
- o No drastic innovations in oil exploration and production technology.
- o Investment dollars will be available.
- o No major changes in government regulation.
- o Additional oil can be found and areas are available for exploration.
- o Relative price stability among different types of fuels.

Some questions:

- o How sensitive is the analysis to marked price fluctuations?
- o What is the impact of increased international competition for oil?
- o Can regulations be expected to remain the same?
- o What is the impact of public opinion in the areas of pollution and environment?

As a result, it appears that forecasts of domestic energy supply must be considered with some caution. One general conclusion that can be made is that near term forecasts are more accurate than long term

ones. Studies completed in 1972 making forecasts for 1985 are probably within 10 percent of being right, since changes in the implied assumptions would take time to make themselves felt in the energy situation.

IMPORT PROJECTIONS

The next step in forecasting is to take the estimated demand and subtract the estimated domestic supply. The difference is then the amount of fuel that must be imported. A refinement in the analysis is the estimation of where the imports will come from. Here, the additional factor of availability by geographic area comes into play. Availability depends on existing reserves and projections of future discoveries. Techniques similar to those used to estimate domestic supply are used to determine these factors. In addition, internal needs of the countries having reserves are considered. For example, the Canadian National Energy Board has refused applications to export an additional 2.7 trillion cubic feet of natural gas to the US.[9] Factors not always considered, except in very general terms, are international competition for the same resource, import-export regulations of both countries involved, international relations, and balance of payments. In general, it is assumed that imported fuel would be available, but then, depending on the orientation of the authors, dire warnings are voiced about national security and the balance of payments.

STUDIES CONDUCTED IN 1972

Recognizing the methodology and some shortcomings of various projections of the energy picture, let's look at three recent studies. These studies are only different from those discussed previously in that they are the most recent available and one of them is more extensive than any made previously. They each suffer to some extent from the shortcomings in methodology discussed in this chapter. One study published in June 1972 was completed by the Energy Economics Division of the Chase Manhattan Bank. The pleas contained in the conclusion of that study are to remove all government controls so that fuel prices can rise to whatever levels are necessary to assure adequate supply, to restore tax incentives for the petroleum industry to increase discovery and production, to adopt more realistic solution to environmental problems so that energy availability is not restricted, and to allow higher profits for the petroleum industry so that capital needed for discovery and production can be made available.[10] As an overall theme, self-sufficiency in energy is advocated as the only acceptable course because of national security reasons. This study forecasts the largest demands and the largest deficit in supply out of the three studies. Although objectivity of the study is hard to question, a doubt lingers in one's mind about the bias of it, especially considering the institution conducting the study and the conclusions of the study.

A second study published in October 1972 was completed by the Department of Interior and used as a basis for a staff study of the potential for energy conservation by the Office of Emergency Preparedness

(OEP).[11] The findings are that imports can be reduced by more than half by adopting certain proposed conservation measures. This study forecasts a rather low demand thereby exaggerating the effects of conservation on the energy deficit. Again, some bias may be evident.

The third study published in December 1972 is the most comprehensive evaluation to date on the overall subject of energy.[12] It is the product of three years of work by more than 300 energy experts of the National Petroleum Council (NPC) working under the guidance of Department of Interior. The end result is a range of forecasts under three conditions of demand and four cases of public sentiment. If any bias can be suspected in this study, it would be due to the fact that a government agency charged with regulating an industry did the work jointly with the industry, perhaps to joint advantage. However, the scope of the study and the number of participants involved would tend to minimize gross bias of figures. The conclusions and recommendations, on the other hand, definitely reflect the fact that this was a petroleum industry study. The main conclusion is that given a free market and adequate incentives, the petroleum industry can supply the needs from domestic sources, at a higher price for the consumer, of course.

SUMMARY OF PROJECTIONS

Since two out of three studies project to 1985 only and previous discussion shows that forecasting farther into the future is subject to greater errors, let's look at the year 1985 more closely. These projections are summarized in chart form in Figure 4. Certain things

SUMMARY OF ENERGY PROJECTIONS FOR 1985

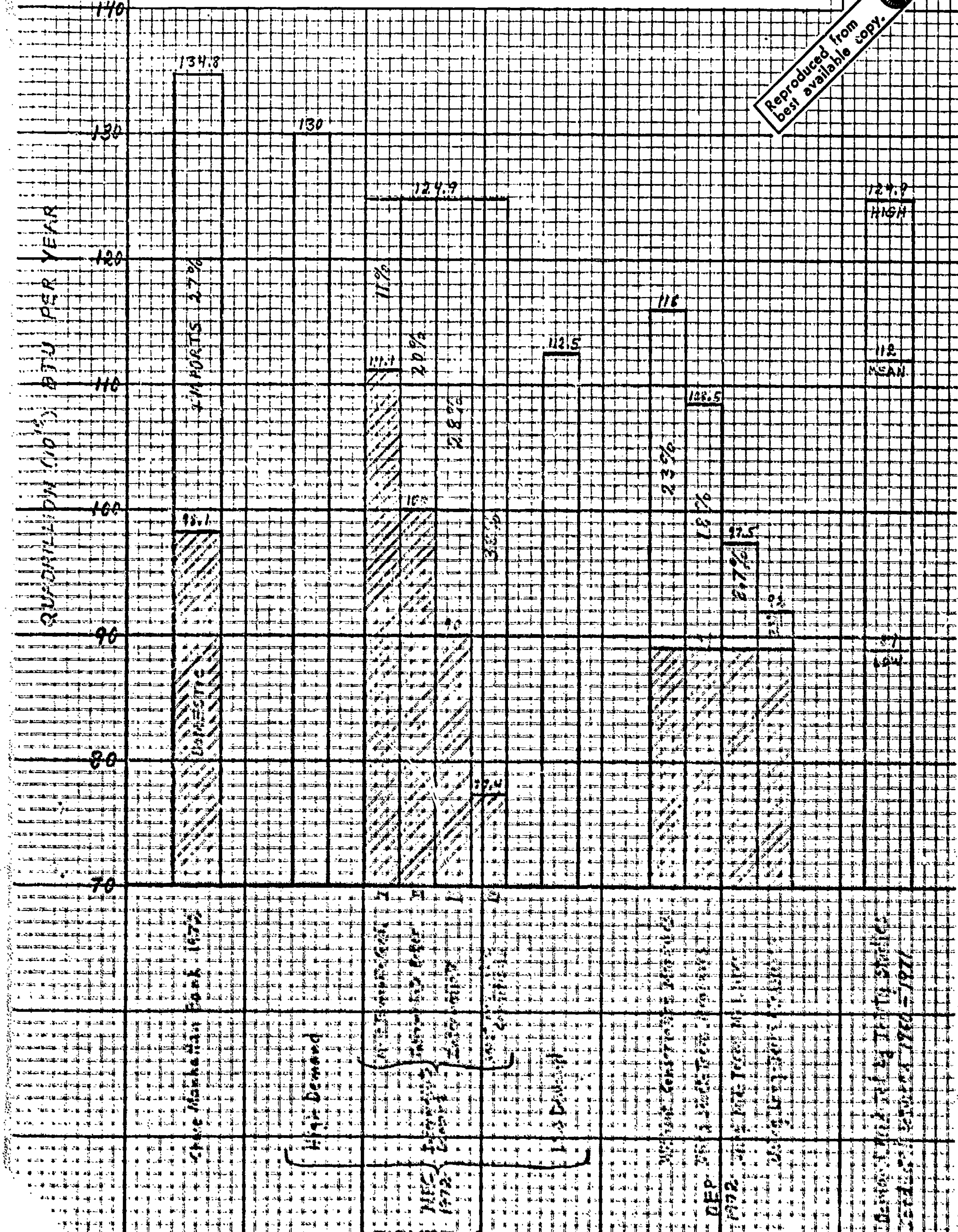

FIGURE 4

stand out immediately from a look at the graphs. The Bank forecasts high demand, large capital requirements. NPC shows that if conditions for the oil industry are favorable, imports can be reduced significantly. OEP shows that a fixed amount of energy will be available domestically, so to reduce imports conservation measures must be taken. But the most significant thing is that all studies agree that the US will have to import energy, in the form of oil and gas, in 1985.

CHAPTER IV

FOOTNOTES

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CHAPTER V

THE REGULATORS AND THE ENVIRONMENTALISTS

The amount of energy produced domestically depends on two more factors, not previously discussed. One is the framework of laws and regulations governing the energy industry. The laws take many forms, from national tax and tax incentive laws, to zoning ordinances of each township, county, or village. Regulatory agencies abound, from the Federal Power Commission (FPC) to the Texas Railroad Commission to the local city Public Utilities Commission. Recently, a second factor has become felt in the energy industry, this is the growth of concern on the part of the public about the environment. Because of space limitations, it is not possible to examine all rules or pressures, nor is it possible to examine any one of them exhaustively. What follows are some of the major topics of controversy between the energy industry, regulators, and environmentalists.

OIL IMPORT QUOTAS

One topic that is being discussed currently is the oil import quota system. Between 1919 and 1922, the US was flooded with crude oil from Mexico. In 1922, an import duty of about 20% was placed on oil because excess productive capacity existed in the domestic oil industry and it was necessary to protect it. This situation existed until start of World War II.[1] In 1946, oil and gas became the principal source of energy in the US, displacing coal. In late 1947 and in 1948 the US suffered an acute shortage of oil and became an importer of oil. The

President issued an order to all Government establishments to save fuel and to: "Keep temperature at 68 during working or waking hours, and 60 at all other times. Heat no unused space above the temperature necessary to prevent damage. Install no new oil-burning or gas burning equipment without the approval of the Bureau of Mines. Waste no electricity and hot water. Do no unnecessary driving and do not drive above 40 miles an hour."[2] On 19 January 1948, Secretary of Defense James Forrestal stated: "The trend of demand as against availability has become such that if military operations or individual living standards in the United States are not to be limited because of an economy of oil scarcity, we must adopt an active policy of favoring sizeable importations of oil. We favor that importation to the extent that it provides needed supply and conserves Western Hemisphere resources, but not to the extent that it would discourage or depress United States exploration and the development of promising major petroleum resources."[3] He also advocated some form of control by setting the largest permissible volume to be imported.[4] A Cabinet advisory committee recommended in 1955 the use of voluntary oil import restraints to maintain the 1954 ratio of crude and residual fuel imports to domestic production. Section 2 of the Trade Agreements Extension Act of 1954 prohibited any decrease in duty on any article if such reduction would threaten domestic production needed for national defense. Section 7 of the Trade Agreements Extension Act of 1955 authorized increased restrictions on imports threatening to impair national security and section 8 of the 1958 Extension Act authorized the President "to take such action, and for such time, as he deems

necessary." In March 1959, President Eisenhower issued a proclamation establishing the present Mandatory Oil Import Program, quoting "certified requirements of national security which make it necessary that we preserve to the greatest extent possible a vigorous, healthy petroleum industry in the United States." For purposes of administration, the US was divided into five Petroleum Administration for Defense (PAD) Districts. District I is the East Coast; District II, the mid-West; District III, the South; District IV, the mountain states; and District V is the area West of the Rockies including Hawaii and Alaska. The Mandatory Oil Import Program regulates the imports through a variety of quotas, allocates imports among domestic companies, and manages program administration by PAD Districts. The quotas are roughly summarized in Table 3.

Import Quota Levels

	Quota by PAD District	
Type of Product	Districts I-IV	District V
Crude Oil	12.2% of estimated domestic production within Districts I-IV	Full difference between estimated demand and estimated US and Canadian supplies produced or shipped into District V.
Unfinished Oil	15% of crude oil import quota	25% of crude oil import quota
Finished Products	Level of imports in 1957	Level of imports in 1957
	District I	Districts II-V
Residual Fuel Oil	Unrestricted	Level of imports in 1957

Table 3

There have been a number of adjustments in quotas by District and type of product at various times, but the general system still exists today. The major result of the quota system has been to maintain a disparity between domestic price of oil and imported oil. The price of Middle East oil f.o.b. East Coast is about $2.25. Domestic oil delivered at East Coast ports is between $3.35 to $3.90. Because of the quota system, the East Coast (District I), which has about 71% of the total nation's demand for residual fuel oil, accounts for 99.6% of the total US residual imports and is now heavily dependent on foreign oil to heat and power utilities, industrial plants, apartment and office buildings, schools, hospitals, and other industrial users.[5]

In February 1970, Secretary of Labor George P. Shultz submitted to the President a report of the Cabinet Task Force on Oil Import Control titled "The Oil Import Question." The report concluded that it was costing the American consumer $5 billion annually to maintain the quota system and that the costs would rise to $8 billion annually by 1980.[6] However, Mr. Dole, Assistant Secretary for Mineral Resources, Department of Interior, testifying before Congress in February 1972 expressed an opinion that these figures never had any real substance in fact at all.[7] Nevertheless, it is obvious that as long as the price of foreign oil is lower, the American consumer will pay a price for the import quota system.

It is ironic that 25 years later, almost to the day, Governor Shapp of Pennsylvania issued a directive to all state agencies that reads the same as that issued by President Truman in 1948: ". . . cut the temperature

in buildings to 68 degrees during the day and 63 degrees at night . . ."[8] The Nation was once again in the grip of an oil shortage during the cold weather in January 1973. On 14 January 1973, an editorial in <u>The Washington Post</u> attacked the White House for causing the shortage through inattention to its responsibilities and advocated ending the quota system.[9] The 1973 energy shortage manifested itself by closing of schools in Denver, Wichita, Kansas, and Nebraska City, Nebraska, by rescheduling of flights by TWA and American Airlines out of New York because of a shortage of jet-fuel in New York, postponing of registration of 38,000 students at the University of Texas in Austin, and heaps of grain in Illinois in danger of rotting because gas was not available to dry it.[10] And that leads to the question of regulation of natural gas.

REGULATION OF NATURAL GAS

At the end of World War II, consumers began to switch from coal to oil for their energy because oil is much more convenient. Instead of stoking the furnace, all one had to do is set the thermostat. An even more convenient energy source was found in natural gas and during the period 1949-1959, residential use of gas increased annually by 10% as coal furnaces were replaced.[11] Gas consumption is six times what it was in 1945. Residential use accounts for 23% of this total growth, but industrial use is responsible for 47% of it.[12] Again, convenience played a key role in expanded usage of gas but the concern for environment, especially air pollution, also played a significant role in the switch to clean

burning natural gas. Facilitating the increasing use of gas is the fact that prices of natural gas are regulated by the FPC and have remained low. Under the Natural Gas Act of 1938, the FPC regulates the pipelines operating in interstate commerce as to wholesale prices and services. Until 1954, the FPC acted as an extension of public utility regulators of each of the states since it was designed to protect consumers from the monopoly powers of suppliers beyond the reach of the state regulatory bodies. The gas producer and the pipeline would negotiate for the price of gas at the well-head and the FPC would take this price as a datum not subject to its control. In the Phillips case of 1954, the Supreme Court ruled that FPC must take jurisdiction over field sales. The influences which built up to this decision arose out of the rapid increase in the well-head price of natural gas as the market expanded after World War II. Now the FPC was caught on the horns of a dilemma since it had to protect consumer interests by keeping prices low and at the same time stimulate the search for new sources of natural gas by providing a reasonable incentive to the producers of gas. At first it tried to apply the same rules to producers as it had applied to the pipelines, that is, cost to establish a regulated rate of return on investment. This led to great difficulties, since each producer had different history of costs and a different price would have to be paid to even the producers in the same gas field selling to the same pipeline. In 1965, the FPC established one level of prices for gas from "old" sources based on historical costs in the producing area and another, higher, level for gas from "new"

sources based on a nationwide sampling of current costs incurred in developing new gas supplies.[13] Whether these policies work or not is subject to debate. Natural gas is the only energy source whose price is regulated by the Federal Government. The American Petroleum Institute maintains that market forces should set real values.[14] In the 1971 Annual Report, the FPC showed that in 1967, 16 trillion cubic feet of natural gas were added to interstate reserves, but only 1 trillion cubic feet were added in 1970, showing a huge drop in exploration for natural gas.[15] On 3 August 1972, the FPC adopted an "optional pricing" policy inviting producers and pipelines to negotiate wellhead prices in excess of area ceilings for "new" gas and on 8 November 1972 approved first such contract at five cents above the ceiling. On 8 November 1972 it also said it would approve price increases for low pressure wells that would otherwise be abandoned.[16] The next day, it proposed higher prices for gas that is flared (burned at the wellhead) because under the commission's present area price ceilings it was not economical to bring this gas to the market. In 1971, 300 billion cubic feet of gas were flared or vented and this amount was equal to one-third of the estimated gas shortage that year.[17] The press has reported that the Administration is thinking of asking Congress to decontrol natural gas prices, if only for new gas supplies.[18] On 7 December 1972, the FPC ruled that it has no jurisdiction over synthetic gas made from naphtha as long as it is not mixed with natural gas in an interstate pipeline.[19] It appears that a trend is developing to decrease regulation of natural gas and to allow an increase in prices in an attempt to stimulate

development, conserve existing resources, and perhaps drive the marginal users to other sources of energy. It did not take long for the consumer to detect it and to counter-attack. On 13 December 1972, Mr. Wheatley, General Manager of the American Public Gas Association charged that: "Thus, there can be little doubt that the predicted winter shortage of natural gas is being used by the industry in an attempt to obtain either higher or deregulated prices for natural gas. Because of the thirst of large, concentrated petroleum companies for unfair profits, natural gas deliveries are being curtailed, supplies of natural gas are being withheld from interstate market and the consumer is being forced to pay higher prices."[20]

The truth of the matter is that both the regulatory process and the gas industry share the blame for shortages. Regulatory process because it kept prices unnaturally low, stimulating demand and stunting exploration and the gas industry because flushed with success and glutted with supplies it failed to invest in research necessary to insure orderly progress and expansion. The consumer will pay the penalty, literally and figuratively.

AIR POLLUTION

An added complication in the energy picture has been the rise of concern about the environment. A simple example is the automobile. Emission controls for cars from 1968 to 1977 will cost on the average $351.50 per car. This is a direct cumulative cost to the consumer. Furthermore, pollution control is costly in terms of additional fuel

consumed. It is estimated that a fully equipped car will use from 15-30 percent more fuel. This translates into 1.7-2.5 quadrillion more BTU's per year required by 1980.[21]

The emphasis on clean air and water has had other effects. The first has been the expenditure of additional capital by industry and the electric utilities for pollution control equipment. It is estimated that the US Energy Industry will invest $30 billion for the period of 1972-1985 in pollution control.[22] The second has been the shift by industry from plentiful but dirty coal to cleaner oil and even cleaner gas. But that has served to aggravate the shortage of oil and gas and to cause more imports of oil.

DELAYS IN CONSTRUCTION OF NUCLEAR PLANTS

While the above actions were taking place, concern for environment has also caused delays in the building of nuclear power plants, which could alleviate the oil and gas shortages to some extent. The enactment of the National Environmental Policy Act of 1969 (NEPA) opened the flood gates of litigation seeking judicial assistance in protecting natural environment. It also set in motion a huge administrative procedure requiring preparation of environmental statements for new power plants, factories, mines, etc. As of 31 January 1972, 2,388 statements were filed with the Council on Environmental Quality (CEQ) by twenty-five agencies of the Federal Government.[23] Some of these statements run into 600 pages and take a long time to prepare, yet CEQ just files them, since NEPA does not require it to review the

statements.[24] The suits that have been brought, have been brought against the agencies preparing the statements. One nuclear plant could not be brought into operation because the cooling water might kill small striped bass.[25] In another case, hearings by the AEC have been going on for three years because opponents are not satisfied that the thermal pollution aspects have been properly evaluated.[26] On 7 March 1972, Mr. Nassikas, Chairman of the FPC testified that $5 billion worth of generating units may be precluded from operation during the first nine months of 1972.[27] The next day, Mr. Freeman, representing electric utilities, testified that regulatory conflict can extend the time it takes to design and build an electric power plant from close to 10 years out to 20 years.[28]

There are other environmental issues impacting on the energy industry and the supply of energy. An auction of exploration rights for off-shore lands was held up for a year.[29] Production of oil and gas on the North Slope of Alaska has been postponed for four years already and litigation continues with a chance that this vast source may never be tapped.[30] Strip mining of coal is under heavy attack because it causes severe "scalping" or scaring of the countryside, water pollution, and erosion, yet is the most economical method of mining.[31, 32, 33] Fear of oil spills has caused delays in the start of planning for port facilities needed to import oil, construction of refineries is hampered by fear of pollution or aesthetic considerations, and the list goes on.

If this recounting of environmental impacts appears one sided, it should not be. In every case, there are legitimate aspirations of the public involved. The emphasis on the quality of life is with us and has

its place among the concerns of government. CEQ has estimated that the annual toll of air pollution on health, vegetation, materials, and property is more than $16 billion.[34] What appears to be lacking is the ability of government to recognize all aspects of a situation and to coordinate and take action within a scheme of overall priorities. There is no question that a clean environment is a desireable goal, but it will have a cost. Part of that cost will be lower domestic production of energy, higher energy costs, and a longer dependence on imports.

CHAPTER V

FOOTNOTES

1. US Congress, House, Committee on Armed Services, Special Subcommittee on Petroleum, Petroleum for National Defense, p. 89.

2. Ibid., p. 88.

3. Ibid., p. 10.

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5. US Cabinet Task Force on Oil Import Control, The Oil Import Question, p. 11.

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21. US Office of Emergency Preparedness, The Potential for Energy Conservation, pp. G13-G15.

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24. Ibid., p. 26.

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26. David A. Andelman, "AEC Staff Report Backs Nuclear Plant for LILCO," New York Times, 5 December 1972, p. 51.

27. Congress, NEPA, p. 364.

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30. Arthur M. Louis, "The Escalating War for Alaskan Oil," Fortune, July 1972, p. 80.

31. "Mine Controls Expected," Evening Sentinel (Carlisle, Pa.), 25 October 1972, p. 2.

32. Frank F. Aplan, "Strip Mining Should be Controlled, Not Banned," New York Times, 10 November 1972, p. 36.

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CHAPTER VI

ENERGY AND NATIONAL SECURITY

CONDITIONS OF NATIONAL SECURITY

It is almost trite to state that adequate supplies of energy are vital to National Security. It is more instructive to examine the foundations of security, its various components, and to see how energy is related to each. To do that, it is important to define "National Security." Some would define it as freedom from external or internal threat. Some think of military superiority. But "National Security" means all of those and more. It means the opportunity for all Americans to pursue their ambitions to the maximum of their abilities within the framework of the constitution. It can best be illustrated as an area protected by a strong inter-linked chain of conditions.

Conditions for National Security

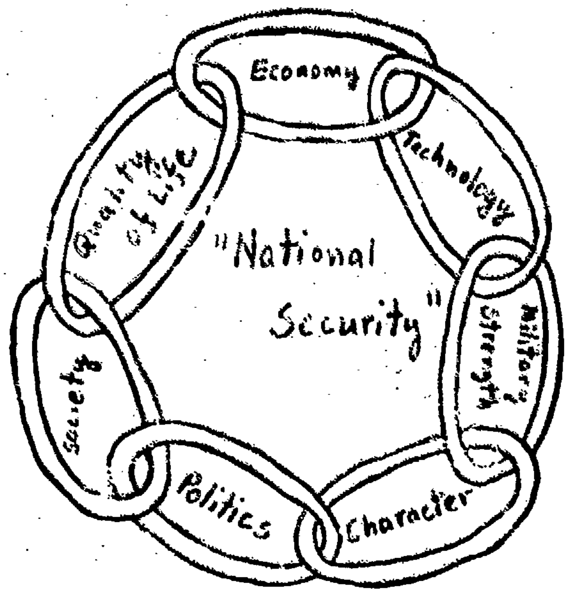

Figure 5

A strong, growing economy is essential to provide opportunities for Americans. The Depression of 1930's was an example of how limited opportunities can become in a shrinking economy. Technology, innovation, creativeness, ingenuity are terms used to describe that unique ingredient that is necessary to get and maintain a viable economy, to provide new opportunities, new fields of endeavor, to solve old problems, and to confidently face new ones. Military strength is needed to minimize the threat of interference with domestic affairs from outside and to insure that other conditions can exist. The character or the will of the people to work together, to stand up for their collective and individual rights is essential to the very existence of a nation. The political strength of a nation in the dealings with other nations depends on the skill of its people and on the strength of all the other conditions making up "National Security." The nature of the society, the social climate, is somewhat like the water in which fish swim. The climate must be such that each member of the society feels that he has enough room and a significant role in it. Abject poverty for a portion surrounded by affluence, unequal opportunities for a segment, political power in the hands of a few, these are the situations which create discord and tear at the very fabric of a nation. Recently, Americans have become aware of the importance of quality of life. This term embraces many things but in general means that clean air and water, scenic beauty, interesting jobs, less crowding, freedom from crime, are goals worthy of pursuit. Any action which leads to soot in the sky, dead fish and foam in the streams, naked hills or oily beaches will be considered as an action

threatening the individual and society. A nation which tolerated above conditions or condoned twelve hour work day in a mine filled with explosive methane gas and coal dust would not be America. So improvement of the quality of life becomes a necessary condition of "National Security."

How does energy affect these conditions of National Security? Obviously it affects all of them and to examine each and every facet is not the purpose of this paper. The purpose is to look at the situation facing the US today, project the situation to 1985 and beyond, and see if a rational policy can be evolved regarding supply and demand of energy based on National Security needs.

From the previous chapters, the US energy situation can be summarized as follows:

o US depends on fossil fuels for 95% of its energy needs.

o US is not self-sufficient in energy today. It imports about 11.5% of its needs.

o In 1985 it will import about 25% of its needs.

o New technology cannot be brought to bear to any significant extent until after 1985.

o Oil and natural gas are the deficit fuels.

o US has sufficient fossil fuel resources to last well beyond the year 2000, but most are not accessible with today's technology.

MILITARY STRENGTH

Let's look at the effects of this situation on military strength. At the outset, it must be recognized that there are two factors to be

considered. The first, is the direct use of energy by the armed forces to fight the war. The source of this energy is almost totally petroleum. Excluding nuclear submarines and ships, the remaining forces need petroleum products for fighting and resupply. The second factor to be considered is the production base necessary to produce the arms and supplies for the armed forces. Today, with the economy operating at over a trillion dollar Gross National Product and at near 90% capacity, it is doubtful that any kind of war would require a large increase in aggregate production volume. Rather, the output mix of goods, would change. Therefore, it is reasonable to examine this second factor under a separate heading of the economy as a whole. There, anything that would injure the economy would impact on military production base.

In looking at direct needs for energy by the armed forces, three war contingencies must be considered. The first is the case of a general nuclear war. If it did occur today or in the future, in the aftermath of a nuclear exchange leaving a shattered economy, domestic sources would be more than enough to provide the crude oil for any remnants of the armed forces. The problems would be how to collect it, transport it, refine it, and then deliver the finished products to the armed forces. Therefore, the fact that the US was or was not self-sufficient in energy at the start of a general war will have no bearing on the nuclear exchange or the conditions immediately afterwards.

The second case is the case of a limited war. The Cabinet Task Force on Oil Import Control examined this case in its report to the

President on 2 February 1970 and concluded that dependence on foreign oil supplies in limited wars does not lead to protracted supply interruptions.[1] The conclusion was based on the history of Korean and Southeast Asian wars. For example, in 1969, the Defense Department purchased about 40% of its fuel from offshore foreign sources and these areas supplied about 90% of the petroleum used in Southeast Asia. Furthermore, the production and distribution of oil is a global and interrelated business. In 1948, Secretary of Defense Forrestal likened it to a balloon. "You take it /in/ one area and it comes out of the hose in China somewhere."[2] The point is that due to the multinational nature of oil merchandising, oil could be cut off to the US by a nation or a group of nations, but their oil could be bought by the US through a third party such as Europe or Japan. A total stoppage of sales of oil to the entire world by the oil producing countries is inconceivable. Therefore, reliance on oil imports would not cause a shortage of petroleum for armed forces in a limited war.

The third and most difficult case deals with a general nonnuclear war or World War II all over again. It is difficult to visualize this type of conflict as being likely but the possibility and its consequences must be looked at. During the peak of World War II, 1,375,000 barrels per day of oil were used for military purposes and for programs supported by the military. This amounted to 33% of US production. It was estimated in 1948, that 2,750,000 barrels per day would have been required for a global war.[3] In 1969, the Defense Department was using 4.8% of total US consumption and estimated a need for 10% (or 1.31 millions of barrels per day) to wage a global war.[4] A long

and fairly thorough analysis of this case made by the Cabinet Task Force came to the conclusion that in all combinations of factors considered, a 10% rationing system would satisfy US needs, even if the US removed the import quota controls and allowed more dependence on foreign oil.[5] A question arises of risks to wartime tanker deliveries. If the US became largely dependent on the Middle East, shipments to the US, Europe, and Japan would be extremely risky and losses would have to be expected. Conversely, if US were self-sufficient in oil, shipments from the US to the armed forces operating outside of the Western Hemisphere would be equally risky. During a general war, an additional option would exist. That option would be of military occupation, peaceful or otherwise, of the oil producing countries, thereby providing land routes or shorter water routes for oil supplies. Even if additional oil were not needed for the US or the US armed forces, the need for oil by our allies may make it necessary to exercise this option. From a purely military view, in a general war, there appears to be no clear cut imperative for the US to follow either policy, self-sufficiency or dependence on imports for the period to 1985.

ECONOMY

Turning to the economy, a different picture emerges regarding the policy of self-sufficiency in energy. Let's assume that the US adopts a policy of importing energy without any or with minimal restrictions. Studies and projections show that US will depend for up to 38% of its energy needs on foreign sources in 1985[6] and for over 51% of its oil.[7, 8] Of course, the hidden assumption is that oil and natural gas will be available on the world markets and that it will

cost less than domestically produced resources. Much emotion has been displayed in the press about these assumptions. Mr. Hickel argues that supply interruptions and pressures from the Middle East are almost inevitable[9] but Professor Mallakh argues that interruptions did not occur, even in 1967, and that producers need revenues just as consumers need oil.[10] Furthermore, the number of oil producing countries or areas is increasing. North Sea, Nigeria, Indonesia, Russia, these are but a few areas beginning to enter the international petroleum market. So the assumption about availability is probably fairly valid. The price assumption is a marginal one. Ever since the formation of Oil Producing and Exporting Countries (OPEC) cartel, the prices have risen. It is quite likely that prices will rise to almost the level of domestically produced oil since OPEC is beginning to show considerable sophistication in economic theory and bargaining.

ASSESSMENT OF SELF-SUFFICIENCY VERSUS IMPORTS

Assuming a policy of self-sufficiency leads to some overall conclusions or assumptions. The first is that some sort of import control will be required since at present domestically produced oil is costlier than imported one. Even under the conditions of a price differential of $1.00 per barrel of crude, domestic oil industry has not been able to keep pace with demand. Presumably, tighter import controls and rising prices will be required to stimulate domestic production. The second is that demand for energy will be the same under either policy. Given these assumptions, Table 4 compares the two policies quantitatively

and qualitatively. Most of the factors are self evident. A word may be necessary about free enterprise. A program of self-sufficiency in energy, with its envisioned import controls will obviously retard the growth of international free enterprise, free trade. In today's era of negotiation, of precarious international monetary system, and of greater interdependence of nations, imposition of strict controls on one commodity by the US can have unfortunate repercussions and set undesirable precedents in world trade. This factor must be given considerable weight and careful consideration in deciding on policy options. Furthermore, domestic free trade appears headed toward restriction under either policy option. Since prices will rise under either option, consumer pressure can be expected for regulation of rate of increase at least. Consumer pressure translated into votes can be safely assumed to override the arguments of the energy industry that the best regulatory mechanism discovered to date for complex problems, is the free market system governed by supply and demand.

Comparison of Two Energy Policies

Factors	Policies: Self-sufficiency	Imports
Transportation investment costs (ships, harbors)	--	$23 Billion
Additional refinery investment costs	Same	Same
Progress in synthesis of gas from coal	Large	Small
New exploration costs	$140 Billion	--
Balance of trade deficit due to energy imports	--	$30 Billion/year 1985
Chances for interruption of supply (other than war)	Very Low	Some
Rise in cost of energy	Larger	Some
Cost of import quotas to consumers	$85 Billion	--
US dealings in international politics	Strengthened	Weakened
Impact on environment (strip mining, oil spills, etc.)	Larger	Some
Progress in new energy technology	Enhanced	Retarded
International free enterprise	Retarded	Enhanced
Domestic free enterprise	Retarded	Retarded
Foreign influence in domestic affairs	Minimized	Enlarged
Social costs (higher prices will affect low incomes more)	Larger	Some
Final exhaustion of domestic resources	Hastened	Delayed

Table 4

A look at Table 4 shows that the choice of policy options is a hard one. The current shortage of heating oil, jet fuel, and natural gas has served to bring out some interesting facets. The first is that short term goals are overriding to the American public. Pressure has mounted and has resulted in the raising of oil import quotas. Similar

pressure has resulted in temporary lowering on air pollution standards so that coal could be used to substitute for oil and gas. The second, a corollary of the first, is that comfort and economics are more important to the public than other conditions of National Security. In the face of such public attitudes and political realities it would seem that energy policy embracing imports is the preferred option.

The choice of such a policy is disturbing. It would be a fairly clear signal to the domestic petroleum industry to increase investments overseas. Given a limited total amount of investment capital, this would eventually lead to a decline in domestic development of energy resources leading to even greater reliance on imports. This would cause growing competition for a limited resource among current allies and might eventually lead to realignment of alliances. At some point in time, the US would be placed in a position where it could not stand a prolonged interruption of supply without a severe crippling of its economy. This would be a point of extreme danger. The Strategy of Realistic Deterrence, as explained by former Secretary of Defense Laird[11] would lose all credibility because of inability to insure mobilization and sustained production and Massive Retaliation would be the only fall-back strategy left. Our antagonists would be sorely tempted to test American Character and the potential for miscalculation by either side would greatly increase. Although not in these terms, others have had similar thoughts.

On 7 June 1972, Senator Mike Gravel of Alaska stated in part:

> In statement after statement, the President, the Secretary of Defense, and the Chairman of the Joint Chiefs of Staff allude to the nation's unspecified 'vital interests abroad' which cost over $70 billion a year to protect. Presumably one of those interests is oil.
>
> Is the American leadership contemplating the protection of oil with nuclear weapons if necessary?
>
> Recent statements by Admiral Thomas Moorer, Chairman of the Joint Chiefs of Staff, provide much food for thought but no answer:
>
> 'An assured capability to deter nuclear war is the essential prerequisite for the deterrence of all lesser types of wars involving Soviet interests, down through the entire spectrum of conflict.'
>
> (February 15, 1972 to the Senate Armed Services Committee, and June 16, 1971 to the Senate Foreign Relations Committee.)
>
> While it may seem incredible, there is hardly any way to interpret Admiral Moorer's comment other than as a re-statement of the Dulles doctrine of massive retaliation--not retaliation for a nuclear attack upon this country, but for lesser Soviet moves . . .
>
> Are the American people willing to die for oil?[12]

Certainly, this is not a scenario to be desired!

On the other hand, self-sufficiency appears to be a costly alternative and not supported by the public. Dr. S. David Freeman, formerly the Director of the Energy Policy Staff of the Office of Science and Technology for the President and now the Director of the Energy Policy Project for the Ford Foundation[13] has called self-sufficiency

a "Drain America First" policy.[14] He calls for coordinated policy, increased research and development, and energy conservation.[15] It should be evident from previous chapters that coordination of policy is essential for any policy. The research and development in the field of energy is interesting. The Fiscal Year 1973 Federal outlays are shown in Figure 6. It is obvious that all the bets have been placed on nuclear energy with very little effort in other fields. As shown in Chapter III, this will not solve the energy problem. A staff study by OEP on energy conservation optimistically predicts that energy demand can be decreased by 20% in 1985 if certain measures are adopted, thereby making the nation almost self-sufficient.[17] The problem with that is that the recommended ways to save energy are to increase costs of energy, to improve house insulation at consumers cost, to use mass transportation, and others which in the aggregate appear to be disruptive to economic development and the quality of life.[18] It is interesting to note that electric power companies themselves are now proposing energy conservation. The Pennsylvania Power and Light Company has gone as far as abolishing their sales department and adopting a company wide program of education on conservation. In spite of that, during the first year of the new policy, demand grew by 8.2% versus previous years growth of 11%.[19] The idea of energy conservation is commendable and conservation must be pursued, but with due regard for all conditions of National Security and within a coordinated over-all policy.

Energy Research and Development
Federal Expenditures FY1973
(Figures in millions of dollars)

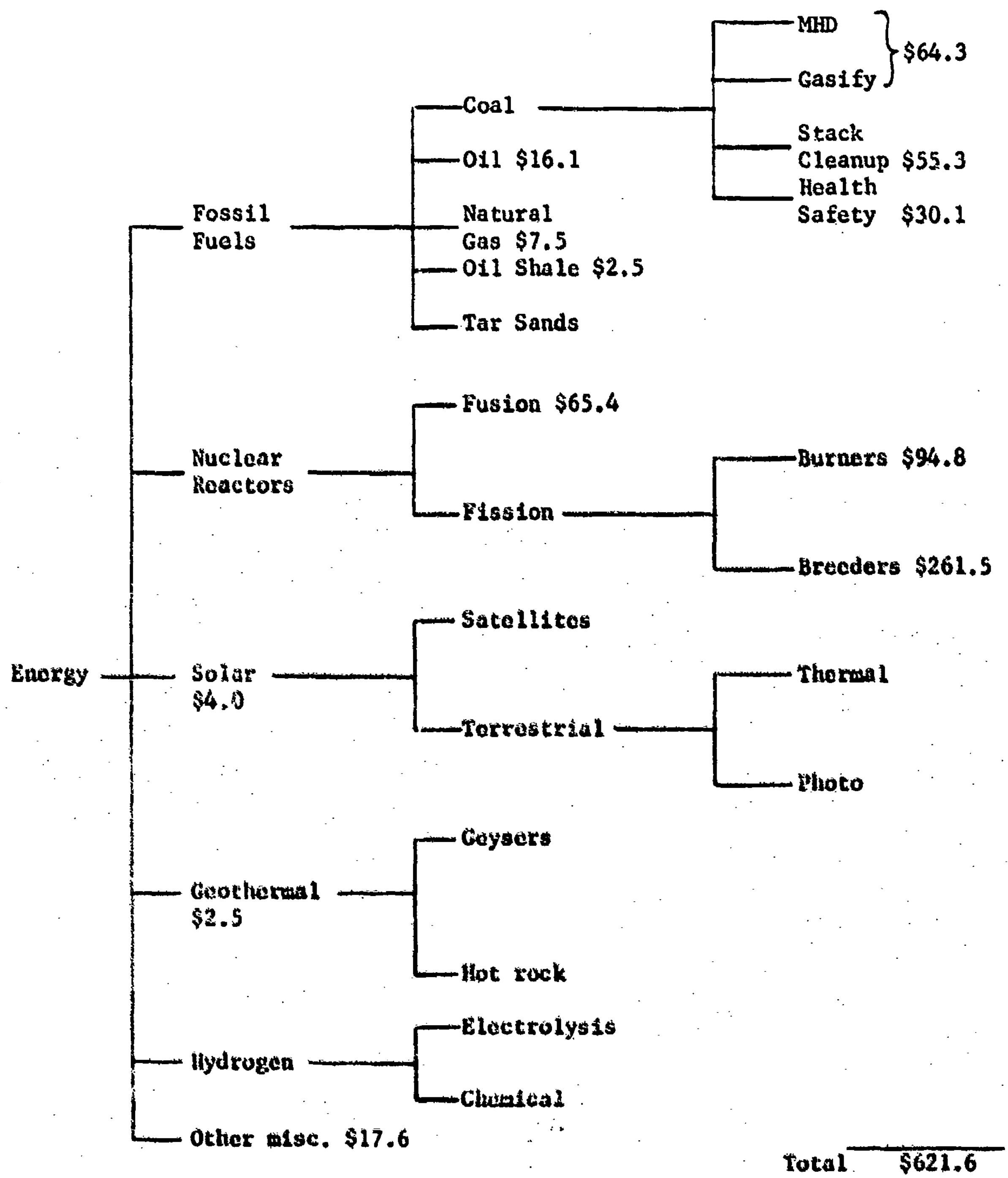

Figure 6
Source: Office of Science and Technology[16]

CHAPTER VI

FOOTNOTES

1. US Cabinet Task Force on Oil Import Control, The Oil Import Question, p. 35 (hereafter referred to as "Cabinet Task Force").

2. US Congress, House, Committee on Armed Services, Special Subcommittee on Petroleum, Petroleum for National Defense, p. 13.

3. Ibid., p. 3.

4. Cabinet Task Force, p. 36.

5. Ibid., pp. 58-65.

6. "Historic NPC Study Lays Out US Energy Options," Oil and Gas Journal, 18 December 1972, p. 14.

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15. Ibid., pp. 334-336.

16. Ibid., pp. 79-87.

17. US Office of Emergency Preparedness, The Potential for Energy Conservation, p. xiv.

18. Ibid., pp. J-1-J-25.

19. Interview with Robert L. Matalonis, Carlisle Area Manager, Pennsylvania Power and Light Company, Carlisle, Pennsylvania, 2 February 1973.

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

From all of the foregoing it appears that the simplistic alternatives for US energy policy of self-sufficiency versus reliance on imports are not viable. As a matter of fact, an outline of a policy is being forced upon us by recent events. The US is already dependent on imports, especially the East coast. It will remain dependent on imports at least through 1985 and probably through 2000. The number of foreign sources for oil and gas is increasing. The detente achieved with USSR and Peoples Republic of China in 1972 will be enhanced by the recent conclusion of a cease fire in Vietnam. The expanding economy in the US will not permit the Administration to take a position which would hinder the economic recovery started in 1971. Such a step is politically not feasible. Nor is it politically feasible to stop or reverse the growing public concern with quality of life. Dimly perceptible is a time when all fossil fuels will be exhausted. Long before that, fossil fuels will become critical as raw materials for manufacture of plastics, cloth, etc. They will be too precious to burn.

A HYBRID POLICY

All these facts seem to suggest a hybrid policy. The policy that is needed is one that will see the US through the period 1973-1985 with relatively cheap, reliable source of energy; will make available cheap, clean and reliable source of energy to gradually replace fossil fuels after 1985; and will do the above taking into full account the needs of National Security as defined in Chapter VI.

It is painfully evident that a policy must be formulated and announced. Equally, it is evident that governmental machinery must be established to coordinate the implementation of that policy. For the period 1973-1985, importing of oil and gas, coal liquification and gasification, start of production of oil and gas in Alaska, rapid completion of nuclear plants under construction or being planned, stimulation of exploration for domestic sources of natural gas, and adoption of reasonable conservation measures offer the way to relatively cheap energy. Reliability of supplies can be enhanced by taking this multiple avenue approach and by making sure that there exists a multiplicity of foreign sources of oil and gas. Import quota system will not allow the attainment of this last objective, but there are other methods available. A country-by-country tariff system, "most favored nation" agreements, are but two possible methods.

In parallel with these actions, research and development efforts must be strengthened and re-oriented with a goal of reducing reliance on fossil fuels starting in 1985. The strengthening of the effort means injection of Federal funds of about one billion dollars more per year. It also means a commitment by the Administration to the goal. The effort must be re-oriented so that all the bets are not placed on one technique. Far too much emphasis has been placed on the Fast Breeder Reactor and far too little on solar, geothermal, or hydrogen energy. A multiple avenue approach is also needed in research and development.

RECOMMENDATIONS

The US should become self-sufficient in energy by the year 2000. It should start reducing reliance on fossil fuels and imports thereof by 1985. It must do so with full recognition that a healthy, growing economy, the leadership in technology, a sufficiently strong armed force, an improving quality of life for its citizens, a just and equitable social structure, a respected position in the community of nations, and a strong will of the people are the necessary conditions of National Security.

To implement this policy it will be necessary to:

1. Establish a policy coordinating body.

The proposed Department of Natural Resources could be charged with execution but either the Council of Economic Advisors or the National Security Council should exercise intra-governmental coordination.

2. Abolish present mandatory oil import quotas.

Substitute import tariffs and restrictions on the amounts of oil and natural gas that can be imported from any one country or a group of countries acting in concert. Use revenue for research and development.

3. Accelerate projects for liquification and gasification of coal.

Grants, support of research, low interest loans, resource depletion allowances are some of the means available to achieve this.

4. Get Alaskan oil and natural gas production started as soon as possible.

Agreements with Canada for a trans-Canada pipeline, counter-suits by the Government against environmental groups, legislation to require environmentalists to prepare "economic-impact statements" prior to litigation, federal financing of environmental safeguards, all should be explored as means to get production started.

5. Encourage prompt completion of nuclear plants under construction or being planned.

Supervision of government agencies making environmental-impact studies must be increased, inter-agency coordination and granting of licenses must be expedited.

6. Partially decontrol natural gas prices.

Seek legislation to remove FPC regulation of well-head prices.

7. Expedite leasing of government controlled lands and off-shore areas.

Potentially gas holding Federal lands and continental shelves should be made available for exploration for natural gas.

8. Implement selected measures to conserve energy.

The OEP study on energy conservation should be expanded and achievable conservation measures implemented. Insulation, appliance efficiency, lighting efficiency, and other standards should be established. Increase taxes on automobiles of high horsepower and weight. Develop efficient and convenient mass transit systems.

9. Increase government support of energy research.

An increase of one billion dollars over present level is necessary to attain goal of reducing reliance on fossil fuels by 1985. Revenues from import tariffs, leases of government lands, automobile taxes should be used for this purpose.

10. Diversify research and development efforts.

The bulk of the efforts should go into research on solar, geothermal, fusion, and hydrogen energy. Each should be pursued with equal vigor to insure diversity of sources and to take advantage of unique advantages of each.

Self-sufficiency in energy -- A National Policy? Yes, tomorrow; no, today!

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